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ABSTRACT

Designed to test the premise that the production system for courseware has a strong impact on the quality of the courseware developed, a survey of 14 U.S. institutions of higher education was conducted in 1986 to investigate the production systems used by these schools. Many of the questions used and the list of institutions surveyed were extracted from a similar study conducted by Potts in 1979, and some additional complementary questions were added. Seven of the schools responded for a response rate of 50%. The results of the follow-up survey showed that, as in 1979, most of the schools found the team strategy in courseware development to be more satisfactory than the individual approach. In addition, nearly all respondents agreed that an instructional system design (ISD) approach should be followed in a systematic fashion, although there does not appear to be a unique ISD procedure or model that would fit the needs of all institutions of higher education. In addition to the emerging micro-based authoring languages, BASIC and PASCAL continue to be important implementation languages for the schools surveyed, combined with main frame computer authoring languages. The text is supplemented with eight tables, and three references are provided. (Author/EW)

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RESULTS OF A FOLLOW-UP SURVEY OF CAI DEVELOPMENT IN SELECTED INSTITUTIONS OF HIGHER EDUCATION

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ABSTRACT

Though the development of courseware (i.e. instructional software) and its implementation in schools was initiated in the U.S.A. in the late 1950s and early 1960s, the overall quality of courseware is still questionable. A bunch of reasons contribute to and may explain this situation. We believe that the **production system** of courseware has a **strong impact** on quality courseware development.

This survey was conducted in December 1986 in order to investigate the question of quality courseware development. The original survey was conducted by **Potts** in 1979. We **extracted** relevant questions from **Potts**'s survey and added some further questions to complement our survey.

Fourteen institutions of Higher Education (within the U.S.A.) were addressed. The response rate was 50 per cent.

In 1979, six out of eight schools deemed the **team strategy** to be **more satisfactory**. In 1986, four of five schools still have the same opinion. One school changed its opinion slightly by claiming this time that there is no difference between the two strategies while having stated that the team strategy would be more satisfactory in 1979.

The survey revealed that, in case of **individual** courseware development, the developers have to attend an in-service course at least, if they do not have any prior computer experience/training.

Nearly all respondents **agree** that (a sort of) an **instructional (system) design approach** should be followed in a more or less systematic manner. Moreover, the survey reveals that there is not a **unique** ISD procedure and/or model which would fit all needs and requirements of institutions in Higher Education.

Besides the (emerging micro-based) authoring languages, **BASIC** and **PASCAL** (still) seem to be important implementation languages for the schools addressed, combined with **main-frame authoring languages.**

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1 INTRODUCTION

Though the development of courseware (i.e. instructional software) and its implementation in schools (especially Universities and Colleges) was initiated in the U.S.A. in the late 1950s and early 1960s, the overall quality of courseware is still mentioned to be questionable by many authors. A bunch of reasons contribute to this situation. We believe that the **production system** (= **production strategy** and **production approach**) of courseware has a **strong impact** on quality courseware development.

This survey was established within a research study (dissertation) to investigate the question of (large scale) quality courseware development.

The next chapter gives an introduction into a survey which was conducted by Potts in 1979. The third chapter offers an overview of all results of the 1986 follow-up survey on a **detailed level.** The results of the 1986 survey are discussed in chapter four, and the last chapter, finally, gives a summary of this report.

2 INTRODUCTION TO POTTS'S SURVEY (1979)

a Rationale

It was **Potts'**[1] goal to identify and describe factors affecting the success of programs in colleges and universities and then answer the prime question behind the research: What are the factors that contribute most to the success of CAI implementation?[2]

She conducted a **literature review** and established a **questionnaire** (with 15 questions)[3] which was sent to **fourteen** Colleges and Universities within the United States. Eight (out of the fourteen) schools were **interviewed** by the author to complement the indications of the survey.

b Extract from Potts's Dissertation[4]

Potts's questions number 1, 8 and 14 are of special interest for our study. As the results of question 14 are **very illustrative,** an **extract** from Potts's dissertation is made:

> Table 13a indicates that eight schools have utilized both teams and individuals to produce CAI curriculum materials. Table 13b shows that six of these eight claim that the programs produced by teams are more satisfactory. The seventh makes the opposite claim and the eighth states that there are "winners and losers" on both." The six remaining schools which responded to these questions were evenly divided in their production method - three teams only and three utilized individuals only - and thus had to make no comparisons.

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[1] A. Potts, A Study of Factors Affecting the Success of Computer-Assisted Instruction in Selected Colleges and Universities, Diss. (Florida Atlantic University), Boca Raton, 1979 (UMI No. GAX79-25611)

[2] A. Potts, 1979, S. 117

[3] A. Potts, 1979, S. 133 - 135

[4] A. Potts, 1979, S. 113 - 115

Table 13a
HOW CAI CURRICULUM MATERIALS ARE PRODUCED
WITHIN INSTITUTIONS

Institutions	Produced by Teams	Produced by Individuals
Dartmouth College		X
Florida State University	X	X
Gallaudet College	X	
Goucher College		X
Howard University	X	
Lake City Community College		X
Miami-Dade Community College	X	
U.S. Naval Academy	X	X
University of Akron	X	X
University of D.C.	X	X
University of Iowa	X	X
University of Notre Dame	X	X
University of Tennessee	X	X
University of Texas	X	X

NOTE: Table developed from responses to second part of Question XIV on survey instrument.

Table 13b
TYPE OF CAI CURRICULUM MATERIALS DEEMED **MORE SATISFACTORY** (OF THOSE PRODUCED WITHIN THE SCHOOL)

Institutions	Produced by Teams	Produced by Individuals
Dartmouth College		All individually produced
Florida State University		**Winners and losers on both**
Gallaudet College	All team produced	
Goucher College		All individually produced
Howard University	All team produced	
Lake City Community College		All individually produced
Miami-Dade Community College	All team produced	
U.S. Naval Academy	**X**	
University of Akron	**X**	
University of D.C.	**X**	
University of Iowa	**X**	
University of Notre Dame	**X**	
University of Tennessee		**X**
University of Texas	**X**	

NOTE: Table developed from responses to third part of Question XIV on survey instrument.

TABLE 1: Tables 13a and 13b from Potts's dissertation

c Why a Follow-up Survey in 1986?

We started our survey called "Follow-up Survey of CAI Development in Selected Institutions of Higher Education" in December 1986 addressing the same schools (fourteen institutions of Higher Education) having in mind the following targets:

1) Related to Potts's survey in 1979:
   - Are the atmosphere and plans for courseware development still the same (covers question number 8);
   - Do the fourteen institutions still develop their instructional software with the same production strategy (covers question 14, part 2);
   - Is the team strategy still deemed more satisfactory by the majority of the institutions which apply both - team and individual - strategies to develop courseware (covers question 14, part 3); and

2) Complementary questions:
   - Have there been changes in the production strategy over time (between 1979 and 1986);
   - What are the reasons for a change of strategy; and
   - Which production system/ISD model is applied?

3) Finally, this survey served as a test instrument for a larger survey which was sent to various institutions in England, Germany, Netherlands, Switzerland, and the U.S.A. in January 1987.

3 RESULTS OF THE FOLLOW-UP SURVEY (1986)

a General Indications

Seven out of the fourteen schools sent the questionnaire back. The respondents are listed in **alphabetic** sequence:

- University of **Akron** at Akron (Ohio) (Computer Based Education Center);
- **Howard** University at Washington, D.C. (Office of Operation Analysis and Institutional Research);
- University of **Iowa** at Iowa City (IA) (Weeg Computing Center);
- University of **Notre Dame** at Notre Dame (Ind.) (Dean of Engineering);
- **U.S. Naval** Academy at Annapolis (MD) (Computer Services);
- University of Texas at Austin (TX) **(UTA)** (Instructional Computing, Coordinator); and
- University of Tennessee at Chattanooga (TN) **(UTC)** (Office of the Ass. Provost for Budget, Personnel and Information Management).

No responses came from Dartmouth College at Hanover (NH), Florida State University at Tallahassee (FL), Gallaudet College at Washington (D.C.), Goucher College at Towson (MD), Lake City Community College at Lake City (FL), Miami-Dade Community College at Miami (FL), and the University of D.C., Van Ness Campus at Washington (D.C.).

This makes a response rate of 50 per cent.[5]

b Follow-up Questions from Potts's Survey

(i) Please check the source of your curriculum materials. If more than one, please indicate approximate percentages.

Acquired from commercial concern (and modified?)
Akron: 15 %
Howard: 70 %
Iowa: 5 % (modified: < 1 %)
U.S. Naval: 0 %
UTA: 40 %
UTC: 50 %

Produced within your school
Akron: 70 %
Howard: 5 %
Iowa: 80 %
U.S. Naval: 80 %
UTA: 55 %
UTC: 10 %

Acquired from (an)other school(s) (and modified?)
Akron: 15 %
Howard: 25 % (modified 25 %)
Iowa: 15 % (modified < 5 %)
U.S. Naval: 20 %
UTA: 5 %
UTC: 0 %

Other source(s)
Akron: 0 %
Howard: 0 %
Iowa: 0 %
U.S. Naval: 0 %
UTA: 0 %
UTC: 40 % (public domain)

No answer
Notre Dame

(ii) If (some) curriculum materials are produced in your school, by whom?

Team(s) composed of...
- Akron:
  SME, student and professional programmer, instructional designer.

- Howard:
  SME, student and professional programmer.

[5] **Cohen & Manion** state that a well-planned postal survey should obtain approximately 40 per cent response on the original dispatch, in: L. Cohen and L. Manion, Research Methods in Education, 2nd Edition, London, 1985, p. 111

- Iowa:
  SME, student and professional programmer, systems analyst, Instructional Designer.

- U.S. Naval:
  SME, professional programmer, systems analyst.

- UTA:
  SME, student programmer, and instructional designer; the designer only with limited participation. Our "teams" most often consist of a faculty member who designs the material then turns it over to a student programmer [generally graduate student] for coding.

Individuals who have/are ...

- Akron:
  Extensive prior computer training, in-service course, was programmer and could call on SME, student.

- Howard:
  Extensive prior computer training, in-service course, programmer who could call on content specialist, student.

- Iowa:
  Extensive prior computer training, and/or was a student.

- U.S. Naval:
  Extensive prior computing training.

- UTA:
  Had one in-service computer course.

- UTC:
  Had extensive prior computer training.

Team and individually produced

Akron
Howard
Iowa
Notre Dame
U.S. Naval
UTA (75 per cent team based, 25 per cent individually produced)

(iii) If curriculum materials for CAI have been produced in your school by **both** teams and individuals, which do you consider **more** satisfactory?

Team produced

- Akron
- Howard
- Iowa
- UTA

Individually produced
- No indications

No difference in quality
- U.S. Naval

(iv) Do present plans include

Expansion of CAI
- Akron
- Howard
- Iowa
- U.S. Naval
- UTA
- UTC

Curtailment of CAI

Maintaining the status quo

No answer
Notre Dame

c Complementary Questions of the Follow-up Survey

(i) What are the advantages (+) and disadvantages (-) of

- developing CAI materials by (a) team(s)?
  - Akron:
    + = More input which leads to more innovation and creativity, more curricular which leads to programs which are likely to be more accurate, specialization leads to better quality, makes individual tasks more manageable, better control of the design, modularization leads to faster completion rate, documentation is more likely to be completed;
    - = Requires structured management, difficulty in reaching consensus, if same teams are used, a team effort can result in too much sameness of end products, requires that everyone completes tasks within time frames, scheduling SME to meet deadlines is difficult.

  - Howard:
    + = You get the CAI materials quicker than before;
    - = Team members have different production and programming styles and these may result in conflicts and delays.

  - Iowa:
    + = Better quality, a distribution of expertise, SME does not have to be a programmer.

  - U.S. Naval:
    + = Teams are more productive; may know the capabilities of the medium better.

- UTA:
  + = Better design;
  - = Time consuming.

- UTC:
  + = Better product, shortens development time.
  - = Cost of staff, team work coordination;

- <u>developing CAI materials by (a) individual(s)?</u>
  - Akron:
    + = Familiarity with project, writing style, programming style, difficulty level are more consistent to the individual needs, questions and problems can be quickly resolved, no time required for communications and meetings;
    - = One person may not possess all skills, overwhelming task for one person, problem of code maintenance, content interpretation is narrow, burnout rate is high.

  - Howard:
    + = The style is consistent throughout;
    - = It takes longer than before to get a finished product.

  - UTA:
    - = Often poor design; not well thought out.

  - UTC:
    + = Less expensive, SME;
    - = Lessens coordination effort, decreased programming effort.[6]

(ii) In 1979 the Vice-Chancellor of your school reported that you develop CAI materials:[7]

- <u>by individuals</u>
  None of the institutions

- <u>by teams</u>
  Howard
  We changed: We use both - individuals and teams - to develop CAI materials.

- <u>both - individuals and teams</u>
  - Akron
    Yes, the decision to use teams or individuals is dependent on the size and depth of the project.)

  - Iowa

  - Notre Dame

  - U.S. Naval

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[6] Unfortunately, there is not further explanation on this aspect.
[7] See A. Potts, 1979, p. 114.

- UTA

- UTC
  Not correct anymore. UTC teams used to write CAI software with the HP2000. When it was removed, we no longer had a CAI authoring language. Coupled with heavy workloads, Academic Computing did not write as much software.

(iii) Are the CAI plans still unchanged? When the answer is "NO"; why did the plans change?

Yes - unchanged
Iowa

U.S. Naval

UTA:
Yes; increased administrational support; IBM and APPLE donations lead to expansion (-_> see Project QUEST Report).

Akron:
Faculty have high interests to administer tests by means of computer (-_> increased development of CMI with plans to eventually incorporate related CAI materials).

No - changed
Howard:
Yes, we changed.

UTC:
Our curriculum project requires more CAI activity.

(iv) Is a (special) instructional design model applied in courseware development?

Yes; which one? Can you give a short description of the main ideas of the model?

- Howard:
  Phoenix: Materials are structured so that they can be divided into units, then into objectives and, finally into screens. Different levels of difficulty are available within a given objective.

- Iowa:
  SW Development and ISD after Dick: Analyze problem, identify subtasks, implement, test, document and evaluate.

- UTA:
  Systematic approach to instructional design with 1) Rationale, 2) Task analysis, 3) Define performance objectives, 4) Storyboard, 5) Code, 6) Pilot test, 7) Revise, 8) Class use, 9) Revise, and 10) Education.

No; why not?

- Akron:
  No single model fits all the University's CAI support needs, however, we tend to build instructional designs that

focus on Condition Variables, Method Variables, and Outcome Variables. In essence, the design of a program is dictated by the discipline itself and the needs of the learner, therefore, one instructional model is not sufficient.

- U.S. Naval:
  Each department or faculty member selects appropriate design.

- UTC:
  Ad hoc designs.

(v) Is it important to integrate the instructional factors (i.e. the instructional knowledge in general) into the production system for courseware development?

Yes; Why?

- Akron:
  It is important to use CAI where it is the appropriate instructional delivery system. Hence you define the demographic, learning and organizational characteristics that impact the instructional problem you are trying to solve. Once CAI is determined to be the appropriate delivery system for a curriculum or course objective, these characteristics are used to define the production techniques that will be used to produce the product.

- Howard:
  Because you need the instructional area to do the integration.

- Iowa:
  Increases the chances of student learning.

- U.S. Naval

- UTA:
  Research results should be incorporated.

No; Why not?

- UTC:
  Available research does not bear this out in CAI.

(vi) Through what means are instructional factors (and other requirements) integrated in the production approach of courseware development?

- Akron:
  By means of analyzing organizational, student and instructional needs. This is done by taking a curriculum approach to selecting instructional delivery systems based on instructional effectiveness and economic factors such as development and implementation costs; i.e. no single delivery system meets all curriculum needs.
  The key to developing effective CAI materials is to make them the system of choice for those objectives where CAI

optimizes the instructional effectiveness and minimizes the costs. This technique helps to identify what models of representation the CAI system will require and how they should be integrated and sequenced within the product and development cycle.

- Howard:
  By checking and testing the related curricula at different stages in the production process.

- Iowa:
  From past experience.

- U.S. Naval (no answer)

- UTA:
  Follows naturally if a systematic approach to design and development is used.

- UTC:
  Instructor/Programmer has this responsibility.

(vii) Are (special) development methods and tools applied for the development of your CAI materials?

- Akron:
  Development Guidelines, Authoring Systems and Languages, Programming Languages, Utilities.

- Howard:
  We use what is provided within Phoenix.

- Iowa:
  Yes, not much use of authoring languages but special purpose SW, and Development tools (scripting, graphics, editors and preprocessor system), team efforts clone by Computing Center.

- U.S. Naval:
  Most involve incorporation of selected video segments.

- UTA:
  "Nothing special".

- UTC:
  NO.

(viii) Do you know other production models of courseware ? Which ones? Could you compare them to your model/guidelines? What are the differences compared to your model?

- Akron:
  A single production model is suitable if the range of application is narrow. However, when serving a broad population and a range of disciplines, a single model is inadequate. Publishers of CAI/CBT materials often use a single development model to serve a specific clientele.

It is customarily a "niche" industry. University requirements are much broader hence single production and instructional models tend to serve the needs of a few specific departments but fail to meet the needs of the majority of potential users. This is the academic development dilemma.

- Howard:
  Yes, Interactive Instructional System (= IIS); Phoenix is easier to use than IIS. In addition, its menus are better and its screen is easier to read.

- Iowa:
  Yes. Many different models in textbooks instructional design and software development. Our model is a blending of the models from both areas.

- U.S. Naval (No answer)

- UTA:
  There are several "systematic" approaches, but all are very similar to the one we use.

- UTC:
  No.

(ix) If you examine these models: Classify their capability of integrating the educational knowledge (instructional factors) in the development process of courseware! Could you indicate your examination in short terms?

- Akron:
  "There is no specific answer to this question.

- Howard:
  Phoenix = excellent; IIS = not as easy to use, but better than nothing.

- Iowa (No answer)

- U.S. Naval (No answer)

- UTA:
  All good production models follow the equivalent of our systematic approach, I believe.

- UTC (No answer)

(x) What programming language(s) are used for developing courseware at your institution? Do you use any authoring language(s), too?

- Akron:
  Main Frame. Phoenix-Pace & Ease; Microcomputer: Micro Phoenix, TenCore, Pilot, Educator, C, Basic.

- Howard:
  Fortran and Pascal are mainly used to develop CAI materials. Howard uses Phoenix as an authoring language.

- Iowa:
  Basic, Pascal, PL/1; very little use of authoring language - some individual use.

- U.S. Naval:
  Basic, Pascal, considering micro-based authoring languages. We will select a micro-based authoring language in the near future. Also we will write our own programs to supplement and/or expand the language.

- UTA:
  Basic = 75 %, Pascal = 20 %, Pilot = 5 %

- UTC:
  Basic

(xi) Please feel free to make any additional comments.

- Notre Dame:
  CAI developments at Notre Dame are solely by initiatives taken by faculty members or groups within departments (there is no central coordination). Consequently, they are fragmented, and there is no collection point for information about them.

- UTA:
  What a deal: To be working on CAI **and** being in Switzerland.

4 DISCUSSION OF THE RESULTS

a Introduction

50 % (or seven out of fourteen) of the schools sent the questionnaire back. Six out of the seven apply both - the individual and the team strategy to develop courseware. Most of the schools which did not respond employed **only one** strategy in 1979 (and thus had not to make a comparison of production strategies).

Not all schools addressed have **centralized** groups which coordinate all the CAI activities within the school. The Office of Operation Analysis and Institutional Research of Howard University, for instance, responded as an office (= **part** of the university) and **not** as a **central** group responsible for the coordination of CAI activities. For the same reason, the University of Notre Dame only answered a few questions; there is no central collection point to gather data related to CAI activities.

However, we believe that the results give illustrative and interesting insights, especially of the question "individual versus team strategy" to develop courseware.

b Discussion

(i) Questions extracted from Potts's 1979 survey

Most schools have **more** than **one** source to acquire courseware materials. Three schools buy 40 to 70 percent of the courseware on the market; but four of them develop courseware "in-house" to a large extent (55 to 80 percent). If courseware is acquired from other schools (e.g. public domain), some of the schools modify these CAI materials.

The second question focused on the production strategy (individual and/or team) and the persons who develop courseware in-house. Table 2 gives an overview of the schools and the production strategies which are applied.

School:	Team strategy	Individual strategy
Akron	X	X
Howard	X	X
Iowa	X	X
Notre Dame	X	X
U.S. Naval	X	X
UTA	X	X
UTC		X

TABLE 2: Applied production strategies

The University of Tennessee at Chattanooga (UTC) is the **only** one (out of the seven schools) which **solely** develops courseware with an **individual production strategy.** All the others employ both - the individual and the team strategy to develop courseware.

Table 3 shows how the schools assemble their teams.

Schools:	Team Members:				
	SME	Instr. Designer	Programmer Student	Programmer Professional	Systems Analyst
Akron	X	X	X	X	
Howard	X		X	X	
Iowa	X	X	X	X	X
U.S. Naval	X			X	X
UTA	X	X	X[e]		

TABLE 3: Skills/Capabilities of team members

All five schools work with a subject matter expert (SME) which is generally a faculty member. Three schools include an instructional designer; two out of the five even integrate a

[e] This is generally a graduate student.

systems analyst. But no respondent indicated that a specialist for graphics design, etc. would be brought in!

Which background and/or capabilities and skills have people that develop courseware individually? Table 4 was developed from the answers to this question.

Schools	Capabilities/Skills of Individuals			
	Prior Computer Training	In-service course	Programmer, call on SME	student
Akron	X	X	X	X
Howard	X	X	X	X
Iowa	X			X
U.S. Naval	X			
UTA		X		
UTC	X			

TABLE 4: Skills/Capabilities of individuals

Most schools require individuals to have prior computer training and/or an in-service course (at least) to become a courseware developer. In other cases, it is a programmer who codes all the materials and can call on (a) faculty member(s) [SME].*

Which production strategy is deemed more satisfactory by the schools? Interestingly, six out of the seven respondents apply both - the individual and the team strategy. Table 5 shows how the five respondents considered this question.

School:	Team produced	Individually produced
Akron	X	
Howard	X	
Iowa	X	
U.S. Naval	No difference in quality	
UTA	X	

TABLE 5: Satisfaction judgement for production strategies

The University of Notre Dame did not answer this question for lack of adequate date. UTC only develops courseware individually.

* This production strategy already points to the team strategy.

It is interesting to see that **no** school which applies **both** strategies considers the team strategy to be less satisfactory than the individual strategy. One (out of five) schools does not see a difference in the two strategies (related to the satisfaction); all the others, i.e. four schools, deem the **team** strategy to be **more** satisfactory than the individual strategy.

The last question selected from Potts's survey focused on present CAI plans of the schools. Six schools are planning an expansion of CAI activities; one school did not answer the question.

(ii) Complementary questions of the follow-up survey

A large list of advantages and disadvantages to develop courseware by (a) **team(s)** was mentioned:

- Advantages
  - Better quality of product;
  - More input which leads to more innovation and creativiity;
  - Distribution of expertise;
  - SME does not have to be a programmer;
  - Teams are more productive and may know the capabilities of the medium better;
  - More curricular which leads to programs which are likely to be more accurate;
  - Specialization leads to better quality;
  - Makes individual tasks more manageable;
  - Better control of the design;
  - Modularization leads to faster completion rate; and
  - Documentation is more likely to be completed;

- Disadvantages
  - Requires structured management;
  - Difficulty in reaching consensus, team work coordination;
  - If same teams are used (for all projects), a team effort can result in too much sameness of end products;
  - Requires that everyone completes tasks within time frames;
  - Scheduling SME to meet deadlines is difficult, time consuming;
  - Cost of staff; and
  - Team members have different production and programming styles and these may result in conflicts and delays;

The following aspects were mentioned referring to the individual strategy:

- Advantages
  - Less expensive than team strategy;
  - Familiarity with project, writing style, programming style;
  - Difficulty level are more consistent to the individual needs; and
  - Questions and problems can be quickly resolved, no time required for communications and meetings;

- Disadvantages
  - One person may not possess all skills, overwhelming task for one person;
  - Problem of code maintenance;
  - Content interpretation is narrow;
  - Burnout rate is high; and
  - Often poor design; not well thought out

Though five (out of six) schools believe that team produced courseware is more satisfactory (than individually produced), advantages and disadvantages of **both** strategies - team and individually produced were stated!

The survey revealed that there are changes in the production strategy over time since 1979. Table 6 shows the comparison over time (between 1979 and 1986).

Schools	Applied strategy in 1979	Applied strategy in 1986
Akron	Both	Both[10]
Howard	Team only	Both
Iowa	Both	Both
Notre Dame	Both	Both
U.S. Naval	Both	Both
UTA	Both	Both
UTC	Both	Individually only

TABLE 6: Comparison of production strategies over time (1979 and 1986)

The University of Tennessee at Chattanooga (UTC) and Howard University at Washington (D.C.) changed their strategy. While UTC only develops **individually** now - and having applied both in 1979 - Howard now applies **both** - while having only included the team strategy in 1979.

At Chattanooga, UTC teams used to write CAI software with the HP2000 in the seventies and early eighties. When it was removed, they no longer had a authoring language. Coupled with heavy workloads, Academic Computing did not write as much software. This brought UTC to the individual strategy.

Referring to the CAI plans, three schools still have unchanged plans. The UTC curriculum project requires more courseware activities. Therefore, plans changed and courseware activities were expanded. Howard did change its plan to expand its activities, too.

[10] The decision to use teams or individuals is dependent on the size and depth of the project at hand.

Another question focused on the instructional design. Table 7 shows the basic characteristics of the instructional (system) design (ISD) procedures which are applied by the schools.

School	Instructional System Design (ISD) procedures
Akron	No single model fits all the University's CAI support needs. However, we tend to build instructional designs that focus on Condition Variables, Method Variables, and Outcome Variables. In essence, the design of a program is dictated by the discipline itself and the needs of the learner. Therefore, one instructional model is not sufficient.
Howard	Materials are structured so that they can be divided into units, then into objectives and, finally into screens. Different levels of difficulty are available within a given objective [Phoenix environment].
Iowa	SW Development and ISD after Dick: Analyze problem, identify subtasks, implement, test, document and evaluate.
U.S. Naval	Each department or faculty member selects appropriate design.
UTA	Systematic approach to instructional design with: 1) Rationale 2) Task analysis 3) Define performance objectives 4) Storyboard 5) Coding 6) Pilot test 7) Revise 8) Class use 9) Revise and 10) Education
UTC	Ad hoc design

TABLE 7: Characteristics of instructional design procedures applied in courseware development

Though most of the schools apply **one** or even **more than one** ISD model, there are schools (e.g. UTC) which conduct this process in a more ad hoc way.[11]

Moreover, it was asked if the integration of instructional factors is considered to be an important aspect within the production approach (= process of developing courseware).

[11] A more exact explication was not given. Perphaps the respondent wants to express the idea of an "intuitive" approach.

Five (out of six) schools consider it important to integrate the instructional factors in the production approach for various reasons:

- Once CAI is determined to be the appropriate delivery system for a curriculum or course objective, these characteristics are used to define the production techniques that will be used to produce the product;
- Because you need the instructional area to do the integration;
- Increases the chances of student learning; and
- Research results should be incorporated;

One respondent believes that the integration of instructional factors is not important because available research does not bear this out in CAI. No further indications were given by the respondent to support this statement.

But what kind of methodology, instruments, etc. support the schools in trying to ensure quality development of courseware?

Various methods and instruments were stated:

- By means of **analyzing** organizational, student and instructional **needs.** This is done by taking a **curriculum** approach to selecting instructional delivery systems based on **instructional effectiveness** and **economic factors** such as development and implementation costs; i.e. no single delivery system meets all curriculum needs.
  The key to developing effective CAI materials is to make them the system of choice for those **objectives** where CAI **optimizes** the **instructional** effectiveness and **minimizes** the **costs.** This technique helps to identify what models of representation the CAI system will require and how they should be integrated and sequenced within the product and development cycle.
- **Instructor/Programmer** has this responsibility
- By **checking** and **testing** the related curricula at **different** stages in the production process.
- From past **experience**; and
- **Follows** naturally if a **systematic** approach to design and development is used.

The comparison of production systems brought the following statements:

- A single production model is suitable if the range of application is narrow. However, when serving a broad population and a range of disciplines, a single model is inadequate. Publishers of CAI/CBT materials often use a single development model to serve a specific clientele.
- It is customarily a "niche" industry. University requirements are much broader hence single production and instructional models tend to serve the needs of a few specific departments but fail to meet the needs of the majority of potential users. This is the academic development dilemma.
- Yes, Interactive Instructional System (IIS); Phoenix is easier to use than IIS. In addition, its menus are better and its screen is easier to read.
- Yes. There are many different models in textbook instructional design and software development. Our model is a **blending** of the models from both areas.

- There are several "systematic" approaches, but all are very **similar** to the one we use.

Another question focused on the implementation language(s) applied by the schools. Table 8 was developed from the answers to this question.

Schools	Implementation environment	
	All purpose language	Authoring system
Akron	Microcomputer: - C - Basic	Main Frame: - Phoenix-Pace & Ease Microcomputer: - Micro Phoenix - TenCore - Pilot - Educator
Howard[12]	Fortran and Pascal (main environments)	Phoenix (Main Frame)
Iowa	Basic Pascal PL/1	Very little use of authoring language
U.S. Naval	Basic Pascal	The school is evaluating an authoring language/system.
UTA	Basic = 75 % Pascal = 20 %	Pilot = 5 %
UTC	Basic	

TABLE 8: Implementation environment(s) for coding

Basic and Pascal seem to be all purpose (high-level) languages which are employed in most cases, but the authoring systems are not to be neglected - especially on the mainframes.

[12] A year ago, some faculty members had the opportunity to attend introductory courses to learn CMU TUTOR and began to develop their first courseware materials. But this is a faculty wide (pilot) project.
For Details see: U. Karrer, In Search for Quality Enhancement Factors (Report), Seon, 1987, pp. 34 - 35

5 SUMMARY AND CONCLUSIONS

Though the development of courseware and its implementation in schools was initiated in the U.S.A. in the late 1950s and early 1960s, the overall quality of courseware is still questionable. We believe that the **production system** of courseware has a **strong impact** on quality courseware development.

This survey was conducted in December 1986 in order to investigate the question of (large scale) quality courseware development. The original survey was conducted by **Potts** in 1979. We extracted relevant questions from **Potts**'s survey and added some complementary questions which covered further aspects.

Fourteen institutions of Higher Education (within the U.S.A.) were addressed. The response rate was 50 per cent.[13] Six out of the seven schools that did not respond this time belonged to the group of institutions which did **only** apply **ONE** production strategy in 1979 and, therefore, are not as important as the others for our purpose.[14]

In 1979, six out of eight schools deemed the **team strategy** to be **more satisfactory.** In 1986, four of five[15] schools still have the same opinion. One school changed its opinion slightly by claiming this time that there is no difference between the two strategies while having stated that the team strategy would be more satisfactory in 1979.

In case of **individual** courseware development, the developers have to attend an in-service course at least, if they do not have any prior computer experience/training.

Nearly all respondents **agree** that (a sort of) an **instructional (system) design approach** should be followed in a more or less systematic manner. Moreover, the survey reveals that there is not a **unique** ISD procedure and/or model which would fit all needs and requirements of institutions in Higher Education.

Besides the (emerging micro-based) authoring languages, **BASIC** and **PASCAL** (still) seem to be important implementation languages combined with **main-frame authoring languages.**

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[13] Seven out of the fourteen schools sent their questionnaire back.

[14] This assumption holds as long as these six (out of the seven) did not change their production strategy over time.

[15] One school - now applying both - only developed courseware with the team strategy in 1979.

6 REFERENCES

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